OpenMind
BBVA

Natural and Technological

Solutions to Stop Climate Change

Sustainability NOTES | #2

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BBVA OPENMIND. NATURAL AND TECHNOLOGICAL SOLUTIONS TO STOP CLIMATE CHANGE

Preface

Climate change caused by humans is a reality. The science confirms it. The international community seems to have reached a consensus regarding the need to take steps to mitigate it and adapt to it. The most urgent is reducing carbon dioxide emissions in the atmosphere - the main cause of climate change. The decarbonization of economies to attain carbon neutrality thus becomes an imperative need, not only to safeguard the health of the planet, but above all, the health of the people who live on it.

This was precisely one of the issues addressed by OpenMind's **first Sustainability Notes**, published several months ago.

Improving energy efficiency, promoting renewable energy, sustainable transportation, responsible consumption and the commitment to sustainable food are some of the strategies that are already being implemented in an urgent and coordinated manner in the most developed economies. Very few question them.

However, there are other, less visible measures with effects that are sometimes less immediate. They receive less public attention, but they can play just as critical a role in the fight against climate change as those mentioned above. They are initiatives that occasionally spark intense debate among the scientific community and citizens themselves. In this second Sustainability Notes, we explore some of them and the controversy that surrounds them.

Since it was established over ten years ago, **OpenMind,** BBVA's community of knowledge, has had the goal of fostering analysis and discussion around the major problems on our planet. And in the fight against climate change, we firmly believe in the need to explore all possible solutions, even those that may seem impossible based on current knowledge. It is increasingly evident that global warming is an enormously complex problem for which a single solution does not exist. As a result, we will have to turn to all strategies within our reach - both natural and technological - to resolve it.

"It is increasingly evident that global warming is an enormously complex problem for which a single solution does not exist. As a result, we will have to turn to all strategies within our reach - both natural and technological - to resolve it".

The restoration and conservation of natural carbon sinks, both terrestrial and marine, rewilding, CO_2 capture and storage technologies and solar geoengineering are some of the issues addressed here. Thanks to experts like Karen Holl, an ecologist from the University of California; Rocío Jimenez, a researcher from Cadiz University; Sebastián Di Martino, the Conservation Director at the Rewilding Argentina Foundation; Mercedes Maroto-Valer, Director of the Industrial Decarbonisation Research and Innovation Centre in the U.K. and David Keith, Professor at Harvard University, we explore each of these proposals in order to better understand the opportunities they offer, and also their risks. From here, our sincere appreciation to all of them for collaborating with this initiative.

Beatriz Rose
BBVA OpenMind Editor

Restoring Ecosystems and Massive Tree Planting

INTERVIEW WITH:

Karen Holl

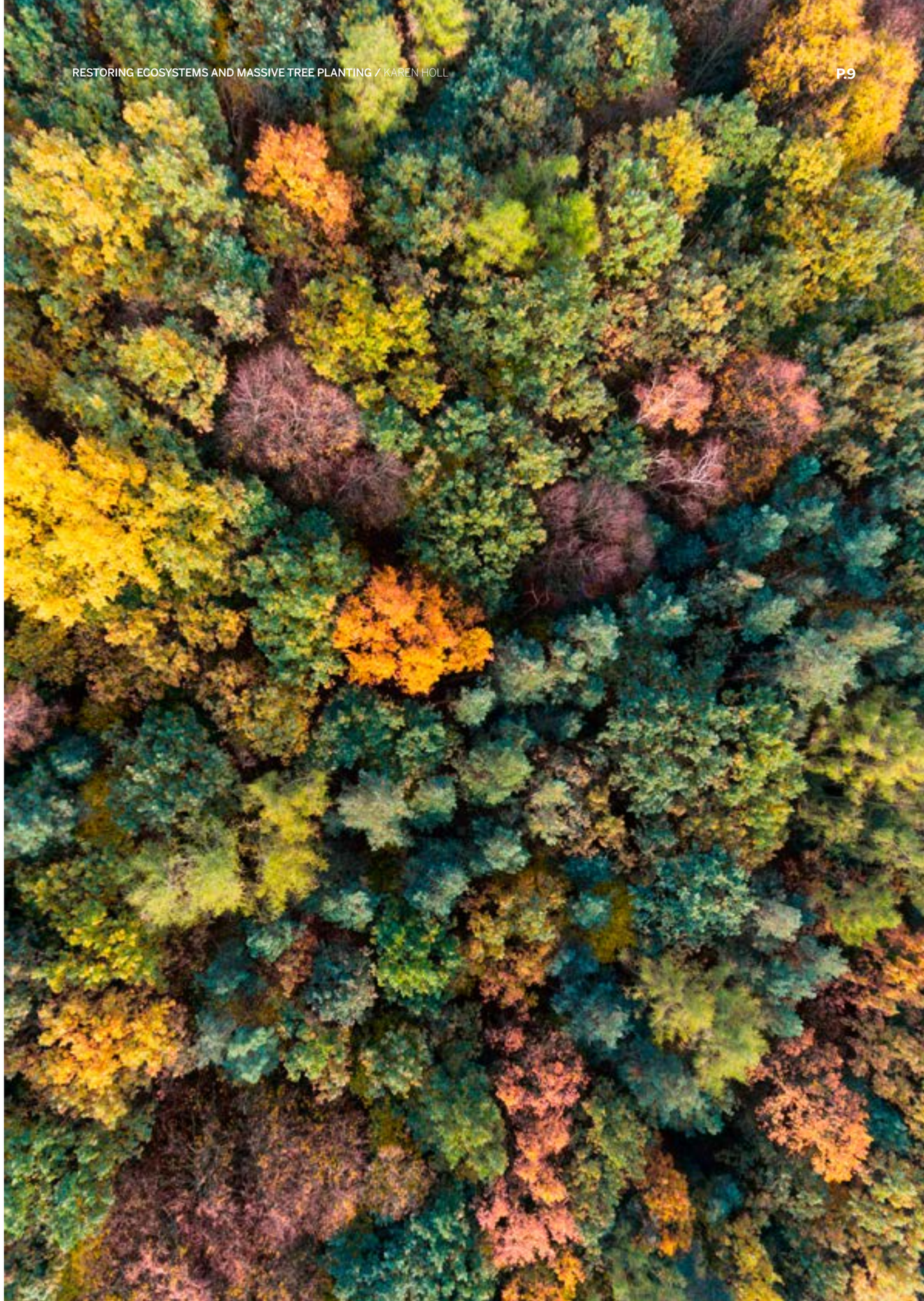
Professor of Environmental Studies at the University of California, Santa Cruz.

Q

Why are ecosystems and forests so important for climate and how can they help fight it?

A

Forests and other ecosystems store a huge amount of carbon above and below ground. The most important thing we can be doing is to keep the existing forests and other ecosystems standing, not planting trees. Forests hold a lot of carbon in them, not only the trees you see but also the soil and roots below the ground. Wetlands and peatlands store a huge amount of carbon and mangrove forests, which are wetlands with trees, have some of the highest concentrations of carbon. So, we want to keep those existing forests and ecosystems there, not only because they store carbon, but because they do it now, whereas if we plant trees, we are going to have to wait. In addition, forests host a lot of biodiversity and we can never put ecosystems back together as well as they are now. This is why we are much better off keeping those ecosystems there.



Q

Do all types of tree species store the same amount of carbon dioxide?

"The most important thing we can be doing is to keep the existing forests".

A

It is certainly species-specific how much carbon different trees store. In general, trees that grow very fast tend to have less dense wood, so they can sequester the carbon faster, but they don't hold quite as much. On the other hand, older trees grow slower but over the long term they're probably going to sequester more. So it depends on the kind of tree and on how large it grows. People focus a lot on above ground carbon, there is also what is happening below ground. Some species will drop a lot of leaves and wood that might put carbon into the soil and there is carbon stored in roots. There are a lot of processes going on.

Q

In the event of a wildfire, **what happens to the carbon stored in the trees?**

A

When a tree burns, carbon dioxide goes back into the atmosphere because it's combusted, unless there is charred wood on the ground. In a wildfire there are often trees left standing which don't burn. It really depends on the intensity of the wildfire. If the fire is not very intense, it can actually clear the understory and the trees that are adapted to fire grow larger. So it depends on what type of ecosystem the fire is in. But there is a lot of carbon that goes up into the atmosphere, particularly if the trees and the shrubs are killed. And so as fires become more intense, more carbon dioxide is being put back into the atmosphere.

Q

Many politicians and company leaders are calling for the planting of millions of trees as a rapid and easy solution to climate change.
What is your opinion?

A

My main answer is no, it is not a simple solution. First of all, we are not going to plant our way out of climate change. Right now we are in a very dire situation. We need to be doing everything we can and taking every strategy we can, but the biggest one we have to be doing is reducing our greenhouse gas emissions. We need to be reducing our travel, we need to be transitioning to green energy, we need to be reducing our consumption of beef which causes the release of methane and often results in the clearing of forest for pasture. We absolutely dramatically need to reduce our greenhouse gas emissions. We can't plant trees instead of reducing greenhouse gas emissions. We need to be planting trees in addition to using every tool we can to slow climate change.

"We absolutely dramatically need to reduce our greenhouse gas emissions. We can't plant trees instead of reducing greenhouse gas emissions".

Second, the most important thing to do is to protect existing ecosystems first. People are planting all these trees in the Brazilian Atlantic Forest, but at the same time the Amazon is being cut down. We need to protect that forest. The same thing is happening in the United States, where there is talk about logging old-growth forests in Alaska, while we're planting trees elsewhere. We need to protect those existing forests first, and also restore and reforest areas.

Third, tree planting is a lot more complicated, we have to do it right. We need to think about where to plant them. We need to take a long-term view and we need to include stakeholders.

Q

What conditions should tree-planting meet in order to be really effective in the fight against climate change?

A

To do the tree planting right we have to include the communities. We need to plant the trees in the right place and make sure they survive and grow. This means planting trees in areas that were previously forested, not into grasslands. There's been a lot of concern about planting trees in very northerly zones, because of what's called albedo, that is, the reflectivity of the Earth's surface. In places like Northern Canada or in those areas where there's a lot of snow, a lot of the solar radiation is reflected back during part of the year. So if you plant trees, it makes it darker and it actually can cause heating. That's one of the reasons people focus a lot on doing reforestation in the tropics and in lower temperate zones, because it doesn't have that effect.

People talk about planting trees, but I believe we should actually be talking about growing trees. To achieve all the benefits that we want from tree growing (carbon sequestration, biodiversity conservation, water supply,...), the trees need to survive and grow. Groups should not only be thinking about how many trees they plant, but also how many trees are alive after five or ten years. At the same time, people are fixated on planting trees, but in a lot of cases, depending on the ecosystem, trees regenerate on their own, so they really don't need to be planted.

Stakeholders are really important if you're thinking of planting trees and projects should be led by local communities. When international organizations come in to plant trees, if people aren't bought in and they're not being compensated for the lost income from their land, they're not going to maintain the trees. In some cases, tree planting has actually increased social conflicts. And there are a lot of examples where groups have planted trees and they haven't been maintained over the long term, so money is just wasted. So the important questions to ask are: How are the local stakeholders involved? Why do they want to do this? And how are they getting money from this project?

One of my biggest concerns is that a lot of these projects are focused on one or two years and trees take much more time to grow. We're going to pay the people to plant them and once the trees are planted, how are people getting money from the land? How do they benefit? It depends on the system. You can do some type of agroforestry, or what's called silvopastoral systems, where people are grazing or doing agriculture within the trees. But if it's not the case, people are being taken out of production and where are they going to go? What will their alternative livelihood be? Are they then going to clear the forest elsewhere? It's what we call leakage or displacement, that is, you plant trees one way, and then people will go clear forests elsewhere. It has absolutely the opposite impact.

Q

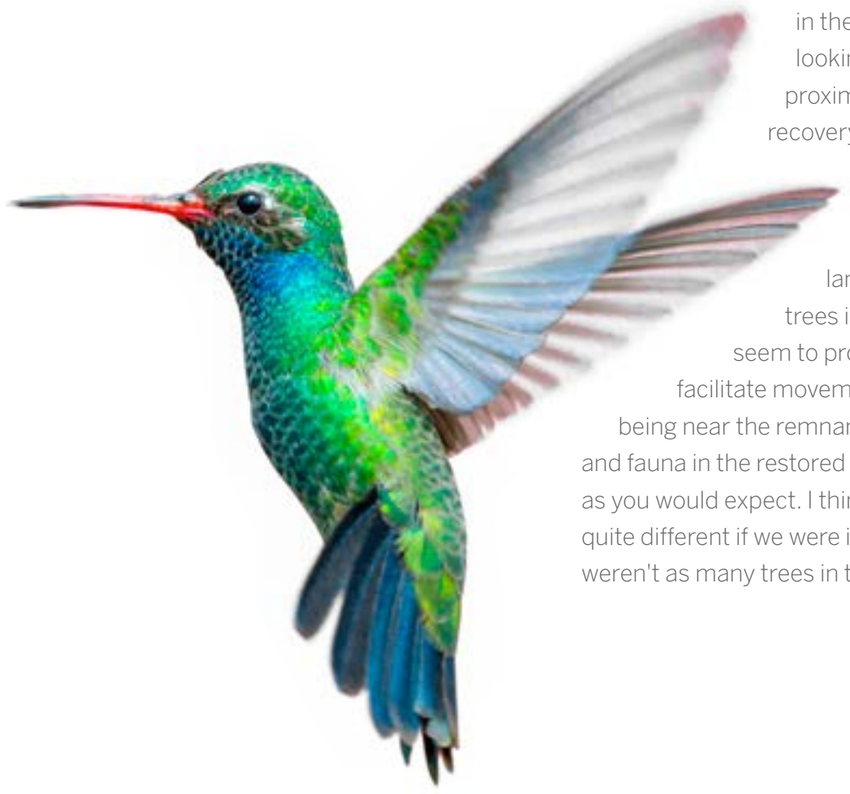
You have done quite a lot of research on forest restoration in places like Costa Rica. **What have you learned?**

A

I've worked in Costa Rica for a long time and we have been planting islands or patches of trees. The idea behind this is that that's how forests recover naturally. We call it "applied nucleation" because these nuclei of trees spread out over time, creating a more heterogeneous forest and attracting birds and bats. That spreads over time and helps facilitate forest recovery. Our results after 18 years show that yes, the nuclei of trees we planted (about 25% of the area) do in fact attract birds and bats which disperse a lot of tropical forest tree seeds. So, it really facilitates recovery as much as these tree plantations, but we only had to plant 25% as much.

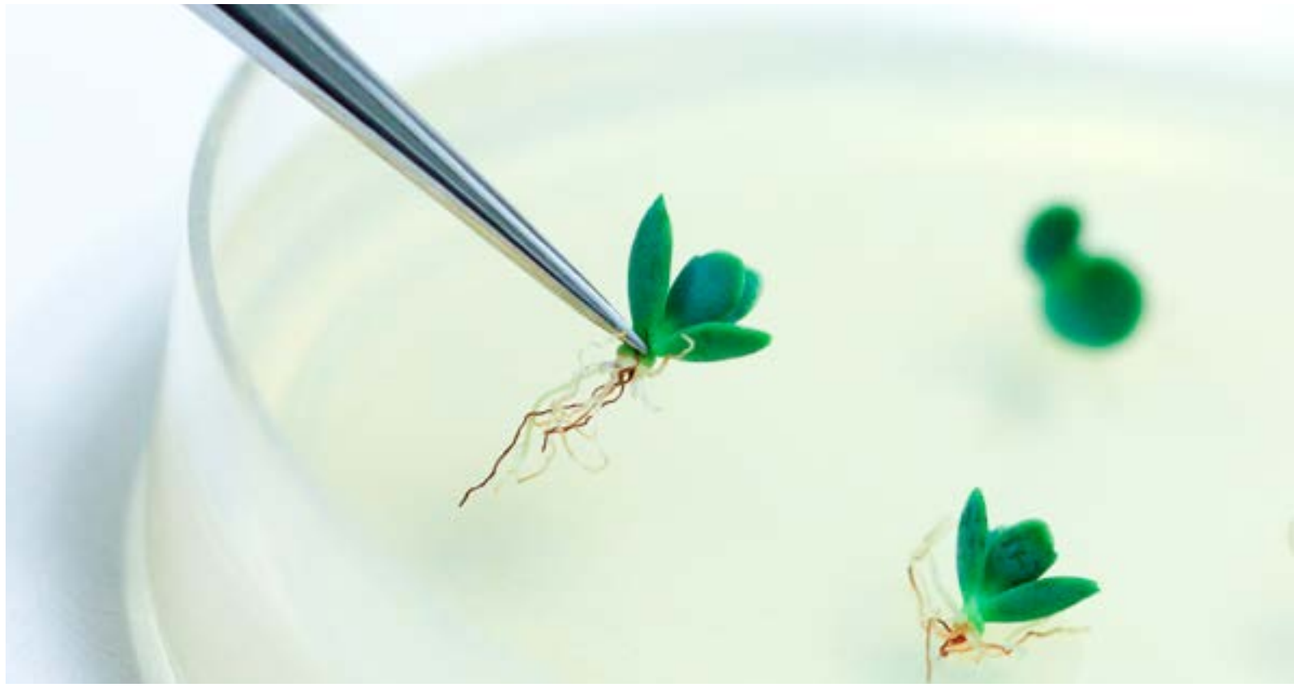
But this strategy doesn't work everywhere. For example, one of my colleagues from Spain, José María Rey Benayas at the University of Alcalá,

"The nuclei of trees spread out over time, creating a more heterogeneous forest and attracting birds and bats. That spreads over time and helps facilitate forest recovery".



did an experiment planting what he calls "woodland islets" which are patches of oak tree plantings. 21 years after being planted, these islands of trees had hardly spread at all. And the reason behind this, we discovered, were the rabbits which were eating the tree seedlings around the edges. So, you need to have different strategies depending on where you're working.

Another thing we have been doing in Costa Rica is comparing some of our plots which are right next to the forest with others which are out in the agricultural landscape, looking to see how important proximity to forests is for forest recovery. Surprisingly we found that it doesn't have a huge impact. But that's partly because, in this particular landscape, there are a lot of trees in the agriculture and they seem to provide sources of seeds and facilitate movement of animal species. So being near the remnant forest affects the flora and fauna in the restored sites but not as strongly as you would expect. I think the result would be quite different if we were in a landscape where there weren't as many trees in the agriculture.



Q

What is your opinion on genetically modifying plants or trees to increase their carbon storage capacity?

A

It's an interesting idea. Environmentalists are generally very worried about genetically modifying organisms and my attitude towards this is that we need to do it cautiously. We've been grafting and modifying trees for hundreds of years. We need to be careful that they're not invasive and that we're not doing things that can be risky, but I'd have to say that it makes sense.

The Conservation of Marine Carbon Sinks

INTERVIEW WITH:

Rocío Jimenez

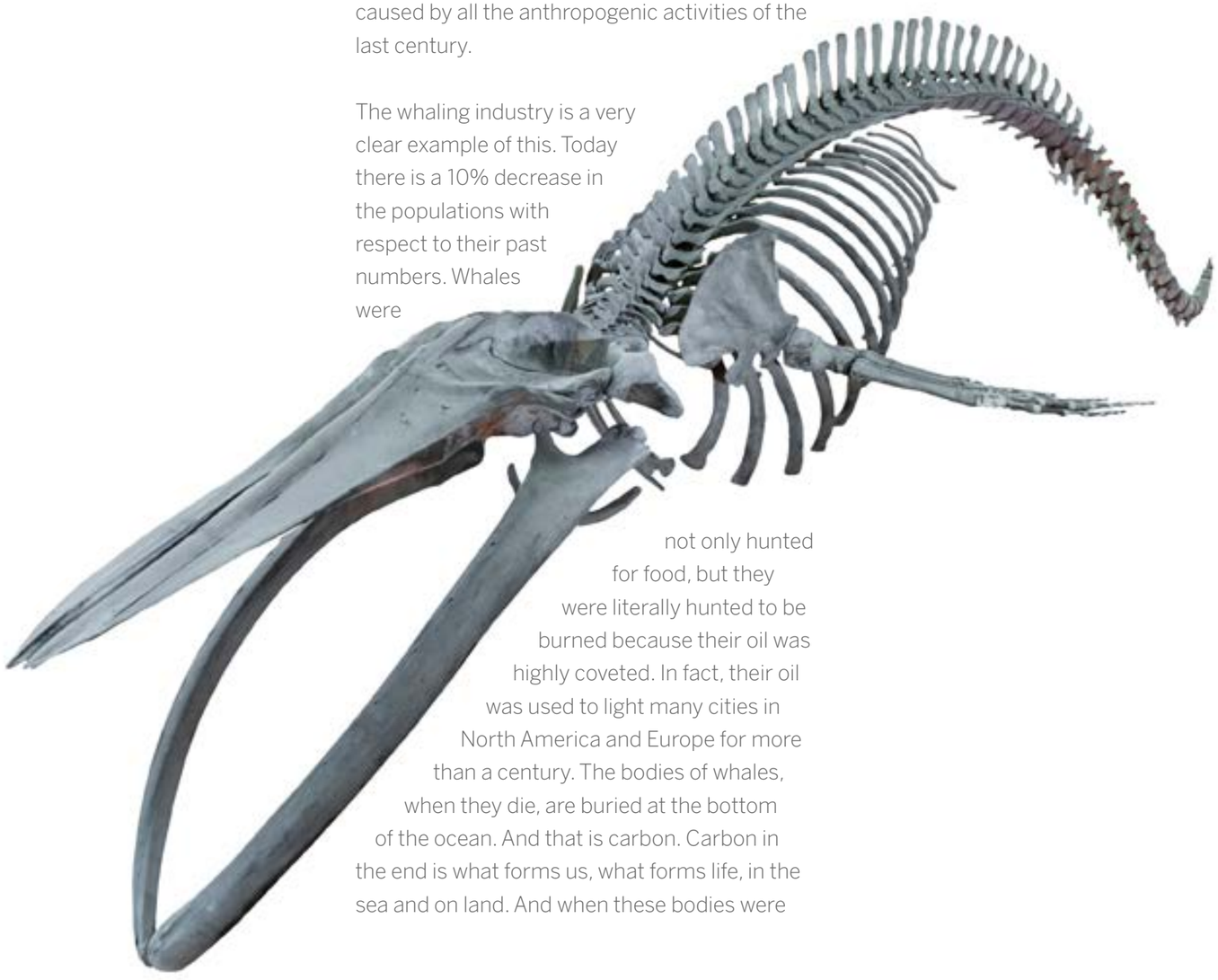
Postdoctoral Research Scientist, Department of Biology, Cádiz University.

Q

Why are we talking about carbon neutrality, what is it and why are we raising this issue now?

A

By the end of the last century we had lost half of the oceans' wealth of life. What we now call blue natural capital, which underpins the entire functioning of marine ecosystems, was being destroyed by leaps and bounds. This destruction is not only a loss of ocean life biodiversity, but has also been one of the drivers of climate change. For example, 38% of the greenhouse gases in the atmosphere come from the destruction and alteration of terrestrial and marine ecosystems caused by all the anthropogenic activities of the last century.



The whaling industry is a very clear example of this. Today there is a 10% decrease in the populations with respect to their past numbers. Whales were not only hunted for food, but they were literally hunted to be burned because their oil was highly coveted. In fact, their oil was used to light many cities in North America and Europe for more than a century. The bodies of whales, when they die, are buried at the bottom of the ocean. And that is carbon. Carbon in the end is what forms us, what forms life, in the sea and on land. And when these bodies were burned, all that carbon was released back into the atmosphere. And so on, all the way up to today's industrial activities.

> "The ocean holds 3,500 years of evolution and can provide answers to the problems facing our planet today".

It was at the United Nations Conference in Rio de Janeiro in 2012 when the issue of the ocean as natural capital arose, that is, the search for solutions to this destruction or to these problems of the planet in nature. Small actions such as reducing emissions by using the car less or using public transport more are very good and necessary, but they are not enough. Since this summit, the ocean has been considered as natural capital, as a structural element of the world economy. Therefore, we must not only know biodiversity, but also understand the services and functions that ecosystems, in this case marine ecosystems, provide, both to the planet and to human beings. This conference was an essential turning point in environmental and social policies and challenges, because the need to find a sustainable and inclusive economic development model was recognized for the first time by all the knowledge stakeholders, not only from the scientific community, but also from politicians, managers and even companies. And at the global level, it was realized that the ocean holds 3,500 years of evolution and can provide answers to the problems facing our planet today.

This is how these nature-based climate action strategies, including blue carbon, came about. These actions are very effective because they consist of decarbonizing the atmosphere as a way to recarbonize the biosphere, all this part that we are destroying.

Q

What exactly is blue carbon?

A

Blue carbon is a term that was coined in 2009. The blue carbon strategy has been growing and has an increasingly relevant role in climate action issues.

Blue carbon is all the carbon that comes from life in the ocean. That is, the carbon that is stored in coastal and marine ecosystems, including habitats, species and even processes that facilitate the absorption of this atmospheric carbon in the ocean and are transported to sediments and deep waters. A very clear example is the primary producers that photosynthesize. They take up carbon dioxide and give us oxygen. Then when they take that carbon dioxide, and use that carbon to build their bodies, to build life. And when their bodies die, some of the carbon is consumed by the food chain and goes back into the atmosphere through respiration, but a lot of it is sequestered or stored in the ocean and through the currents it reaches the deep ocean and gets stored there. This is the blue carbon.

Q

How is climate change affecting the ocean and marine ecosystems?

A

The ocean faces many threats today. When we talk about climate change, there are many variables that have an influence: global warming, acidification or overfishing. All these variables influence, through a series of processes, the reduction of blue carbon stocks.

For example, in the last 60 to 70 years, the atmosphere has received two thirds of greenhouse gases since the Industrial Revolution. Considering that 83% of the carbon cycle is in the ocean, most of this contribution comes mainly from the destruction of the functions and goods and services provided by this natural capital. All the alterations that come from climate change (and most of them come from anthropogenic actions) are reducing the ocean's capacity to store carbon. We are releasing that carbon that should be sequestered in the ocean, we are returning it to the atmosphere, and it is contributing to the greenhouse effect that we are suffering from climate change.

This can be seen very well in coastal ecosystems, which are the great forgotten ones. As I was saying, 83% of the global carbon cycle takes place in the oceans. And half of all this carbon that is stored in the ocean is found in coastal ecosystems.

When we talk about the ocean, everyone thinks of the deep ocean, huge bodies of water, with lots of depth, whales and sharks, but coastal ecosystems, even though they only cover 2% of the entire ocean surface, are the big heroes in storing blue carbon.

Q

Are there marine plant species that are more "efficient" at absorbing carbon?

"Seagrasses are one of the ecosystems that have been called "heroes" in blue carbon contribution".

A

Coastal ecosystems are made up of diverse habitats. The main ones are salt marshes, mangroves and seagrasses (or seagrass meadows). In general, mangroves or coral reefs are much better known than seagrasses, which are large submerged forests, and one of the ecosystems that have been called "heroes" in blue carbon contribution, but are still largely unknown.

Seagrasses, globally, only occupy 0.1% of the entire ocean surface, but they remove one third of all the carbon that is sequestered annually on the seafloor. In other words, their contribution is very, very important.

In science, seagrasses have also been largely uncharted waters. It was only seven years ago that a paper was published in which the first seagrass genome was sequenced. That is a very short time. It happened to these plants (they are plants, not algae because they have roots, seeds, leaves and flowers) as it happened to dolphins, which used to live on land and gradually adapted to the marine environment. When the genome of these prairies was sequenced, the incredible adaptation that these plants underwent to colonize the ocean became evident, and it was then that it was understood why there are only 60 species compared to the more than 300,000 species that exist in the terrestrial environment.

And why do these seagrasses store so much carbon? These seagrasses grow by extending their rhizome, which is like a small trunk that is under the sediment, like a subway stem, and slowly elongates. These plants grow very slowly, at a rate of between one and five centimeters

per year, and branch out throughout the seafloor forming large clones.

Their leaves (which we call canopy) grow upwards in the water column in order to have enough light for photosynthesis. This canopy is very extensive and very dense and they form very productive ecosystems, generating a lot of oxygen in the system and promoting a lot of carbon. If they produce a lot of oxygen this means that they are sequestering a lot of carbon through photosynthesis. And much of this carbon is sequestered in the marine subsoil, especially through those rhizomes, those roots that are very difficult to decompose. They stay there when the tissue is dying, they just stay buried in that sediment. So all that extensive canopy, all that density of leaves, also forms a network that dissipates the energy of the currents. In other words, the marine currents, when they collide with these forests, slow down and therefore filter suspended carbon particles from other organisms that also precipitate in the marine subsoil. These particles decompose very slowly because their sediment becomes quite anoxic as the depth of the sediment increases, i.e., there is less and less oxygen and that slows down the microbial decomposition of carbon. Therefore, that carbon accumulates and is preserved for thousands of years in these ecosystems.

"In the last 10 to 20 years it is estimated that we have lost a third of the known areas of seagrasses worldwide, although there is still a lot to be discovered, because they are largely unknown ecosystems".

Q

What is the current situation of seagrass meadows?

A

Climate change is affecting them a lot. We have lost a large area of seagrass around the world. It mostly started in the 1930s, with the so-called wasting disease, which was a brutal influx of sewage and agricultural runoff into the coastal system, caused by the population growth that took place and caused a huge mortality of these seagrasses along the coasts of the entire planet. And this is further aggravated by other damages that they suffer especially by the dragging of anchors or dredging of the coast, which make a plowing action of all these habitats and are eliminating all these marine plants. And not only are they destroying the populations but they are removing and suspending all that sediment that is storing the carbon and it is being emitted back into the atmosphere. In the last 10 to 20 years it is estimated that we have lost a third of the known areas of seagrasses worldwide, although there is still a lot to be discovered, because they are largely unknown ecosystems.

Q

Can these meadows be repopulated or reforested?

A

These plants grow at a very, very slow rate and their reproduction is practically clonal. They have very little sexual reproduction. This means that, apart from the fact that their growth is slow, there is little success when trying to repopulate. Repopulation activities are being carried out, some with very positive results, but it is true that efforts should focus more on preserving what there is. When it comes to restoring these ecosystems, the

The green turtle (*Chelonia Mydas*) is part of these ecosystems.

problem is that we need seeds, because with adult shoots success is not so guaranteed. To take these seeds we have to destroy a meadow that already exists in order to repopulate others, so these are complicated actions.

Efforts should therefore be directed towards conservation. Policies are currently being implemented to protect and conserve seagrass meadows and, above all, to improve the water quality of these habitats. The results are quite encouraging, as the last two decades have seen a rebound in the expansion of these populations that have been under protection after almost a century of sustained decline. That is why we must continue working on the conservation and recovery of these grasslands and, above all, focus on protecting and conserving what is already there.

P

There are projects underway that are betting on "less natural" interventions in the ocean such as cultivating seaweed and sinking it in the sea to enhance carbon absorption and storage or introducing minerals into the sea to retain more CO_2. **What do you think about these solutions?**

A

All these solutions are still under scientific debate as we cannot control all the variables that occur in an ecosystem such as the ocean.

For example, on the coast, there are companies that inject part of the CO_2 they emit into the subsoil, into the sediments of the seagrass beds, which are not yet saturated to capacity. The problem here is that they only look at the capacity of these plants, but what about the fauna there? In the end you are acidifying a sediment, and this affects the bacterial community as well. You can generate an unwanted domino effect.

"Policies are currently being implemented to protect and conserve seagrass meadows and, above all, to improve the water quality of these habitats. The results are quite encouraging, as the last two decades have seen a rebound in the expansion of these populations".

Nature is much wiser than we are, and that's why I think efforts have to focus on protecting and conserving what's there, and doing science, really understanding how ecosystems work, because we really don't know everything yet.

Sunset in the Carboneros marshes, in Chiclana de la Fontera, Spain.

Q

What is the blue carbon market and what role can it play in environmental conservation?

A

Environmental action, the achievement of solutions for the planet, will only come when it occupies a central role in our society. Until now, it has been relegated to the scientific sphere and to purely voluntary contributions by individuals and companies. However, environmental action must become an engine of the economy that can generate quality jobs, for example. It should not only be an ethical commitment from the population or companies.

"Environmental action must become an engine of the economy that can generate quality jobs, for example. It should not only be an ethical commitment from the population or companies".

This gave rise to the idea of the blue carbon market, which had its beginnings in the United States, with the Verra Protocol, in which companies made voluntary commitments to invest in environmental actions. The problem was that this system was not regulated, which meant that companies could make commitments and then fail to comply with these agreements and nothing would happen.

In Europe, this has begun to be done in a regulated manner with the help of the administrations, with a protocol of this blue carbon standard, giving rise to the first blue carbon market in the Eurozone. And the International Union for Conservation of Nature (IUCN) has focused on the Cadiz marshes as an ecosystem to develop this project.

This choice is not accidental since the marshes of the Bay of Cadiz is a unique ecological space that has been shaped by man, by the use of salt marshes and estuaries, since the time of the Phoenicians. The problem of these ecosystems is that they are very degraded, the marshes are very abandoned. Therefore, creating private investment plans and actions to restore and preserve all these marshes, in a regulated manner and following a standard in these blue carbon bonds, can be one of the solutions to introduce this environmental action in the economy.

Rewilding: Conservation and Recovery of Natural Ecosystems

INTERVIEW WITH:

Sebastián Di Martino

Conservation Director,
Rewilding Argentina Foundation.

Q

What is rewilding? What is its goal?

A

'Rewilding' is a term that was born in the 1990s, tied to the conservation of large carnivores in extensive spaces - a period in which the fundamental role that large spaces have on the survival of these species started to be recognized. From there, rewilding became a very popular term.

It is a term that emerged from realms of conservation activists - not from academic realms. Therefore, it is a little bit difficult to pigeonhole. Each of them have their own definition within a general framework. For us, rewilding is an environmental restoration strategy that aims to recover or restore complete and functional ecosystems.

The anteater or *yurumí* is the emblematic species of El Impenetrable National Park, Chaco, Argentina.

Complete ecosystems are those that have all their species present - in other words, the species that lived in them in historic times. But species not only have to be present; they have to be present in a sufficient amount to be able to fulfil their ecological roles. These are functional ecosystems.

For example, in Chaco, we are working at a national park where there is only one male jaguar left. In this case, the species is present, so the ecosystem is complete, but as there is only one, it does not have an impact on the ecosystem as the top predator (meaning, at the top of the food pyramid). In this case, ensuring that there are sufficient numbers to have a functional ecosystem is the goal of rewilding.

And how is the species to recover selected? Ecologists have defined what they call 'keystone species'. They are species with very important ecological roles in the ecosystems and when they

"These large predators eliminate the weaker or ill herbivores, thus ensuring a more stable balance of pathogens in the ecosystem and preventing the spread of diseases".

are not present, they start to degrade - they no longer function well.

In the framework of this rewilding strategy, we try to return the keystone species that the ecosystems have lost. These keystone species are generally large predators or herbivores that are normally at higher levels of the food chain. And all the adjustments that they make in the ecosystems, they do so through these relationships in the food chain.

From there, for example, comes the importance of working with the jaguar, as it regulates the populations of herbivores - not only in their abundance, but also in their behavior, which influences the vegetation and carbon sequestration rate. These large predators eliminate the weaker or ill herbivores, thus ensuring a more stable balance of pathogens in the ecosystem and preventing the spread of diseases.

Q

What criteria are used to select a space or specific ecosystem to restore? Who makes this decision?

"Rewilding Argentina Foundation creates economies that restore the environment, in other words, local economies that the more they prosper, the more the environment prospers. It's a model we call "production of nature".

A

At the Rewiliding Argentina Foundation, the decision is made by the executive director, the administration director, a scientific director and me, the director of conservation. In terms of how we select the ecosystem to recover, first it should be an important place due to its biodiversity. It must be a large territory that is not under threat, and species must be reintroduced that were sometimes eliminated because they created conflict in the area, like the jaguar, for example.

It is not easy to get the social license, first of all, and then the political and technical permits needed to create a large park and bring back predators. What the Rewilding Argentina Foundation does is create economies that restore the environment, in other words, local economies that the more they prosper, the more the environment prospers. It's a model we call "production of nature".

And how is this done? First, the foundation raises funds to buy land - mainly cattle fields. Once the livestock is removed, this land is donated to the state to create a national or provincial park. The problem is that creating a national park is very complicated in Argentina, as it also requires the approval of the province where the land is located.

From the moment that the foundation purchases the land, they are opened to the public and we invest in infrastructure for public use. In the same way that cattle fields have cows, for example, on this land we have a park with wildlife: we raise jaguars, marsh deer, pumas, etc. That is our "production". By producing this wildlife, we recover the ecological roles, and at the same

Woman kayaking on a lake in the El Impenetrable National Park, Chaco, Argentina.

time, generate spectacles of docile and abundant fauna, because the fauna is increasingly more abundant and visible.

And how is this production "harvested"? Through nature tourism based on observation of the fauna. The local population is in charge of this - the people who live in the area. In order for this to be possible, having good public infrastructure is needed, on the one hand, and people that come to see fauna, not landscapes, on the other.

In other places of Argentina, like the Iguazu Falls, or the glaciers, tourism of nature is based on observation of landscapes. It is a contemplative tourism - not an experience - and local residents do not enter into the equation. Buses come from far away, with 200 or 300 people accompanied by guides from Buenos Aires - not from the area.

"If you generate tourism activities with a high level of experience, that is where the local population starts to play an important role and can become entrepreneurs".

However, if you generate tourism activities with a high level of experience, organizing horseback riding or hikes, kayak or canoe rides - that is where the local population starts to play an important role and can become entrepreneurs. It is therefore creating an economy in which local people start to earn money, organizing these tourism activities, offering food that is typical of the area, lodging or crafts. But not only that - there is also a recovery of culture, pride and identity for local communities.

This is the way that the local populations starts to see that the park and its fauna have a useful role - they are drivers of economic development and job creation. And that's how the social support for the creation of the park and the reintroduction of species starts. As soon as there is social support, it is transferred to the political world. At some

point, the territory becomes a national park and the government is in charge of taking care of it and building the public infrastructure The time comes for us to end our intervention. That is the reason it is so important to create a sustainable economic model that can be sustained over time.

Marsh deer (*Blastocerus dichotomus*).

Q

Is rewilding applied in the same way all around the world? Which countries are more advanced?

A

There are different levels of progress. The foundation's Iberá project is probably the largest species reintroduction project in the Americas. In Latin America, it is a conservation strategy that is used very little, although like everywhere, it's growing. In Brazil, there are some multi-species reintroduction projects like the Tijuca National Park and other projects to reintroduce specific species.

Without a doubt, Africa is where rewilding is done one a much larger scale, with a much greater impact on conservation. In Europe, there are also reintroduction projects like the Iberian lynx in Spain, the European bison in several places, or the beaver in Scotland. However, they are more classic restoration, regeneration of pastures or forests, the basic parts of the food chain. We focus more on the higher parts of the chain.

Traditionally, conservation has consisted of "not touching", of protecting what is still left standing. And that is necessary, but not sufficient. This other strategy of active management needs to be carried out. A cultural change is needed and that is hard. And there are also reactions against it.

Q

What is the main criticism that rewilding receives?

"One of the common critiques is that by starting populations with a low number of individuals, they will experience genetic problems in the future".

A

There is a lot of criticism that is more related to a cultural change regarding how to do conservation. There is a sector of the conservation world that is not used to this type of strategy and they oppose it, using technical arguments when in reality, it's more of a cultural discussion.

For example, one of the common critiques is that by starting populations with a low number of individuals, they will experience genetic problems in the future. Another critique is that if animals are moved from one place to another, pathogens will also be transferred. Or that if the species for which reintroduction is being attempted never lived in that place, it isn't actually a reintroduction, but an introduction. This criticism can all be addressed.

Although it starts with a few individuals, the genetic problem can be managed. On the other hand, there are examples of species recovery that started with just a single male or female because only one was left. Of course it is ideal to start with a more or less large number of specimens, but if it isn't possible, it doesn't mean that it won't be successful. But directly not doing a project because of the risk of pathogen transfer doesn't make sense. If we based the decision of whether or not to do transfers on this, we wouldn't transfer livestock or people.

Q

Is there some kind of global coordination of the different national rewilding initiatives?

A

We look for organizations that work on similar issues and share information. We send our teams to Africa, for example, to see how they work there and learn from their experiences. But there is no formal network established to exchange information.

In our case, when we started to work on reintroducing the jaguar, we went to Brazil to learn about the pens, to know how to handle these animals and learn to live with them in freedom. People from Africa also came to advise us. We definitely took advantage of the experiences of other organizations in other countries.

In a few days, we are going to participate in the first Global Meeting of Translocation Professionals for Conservation, which will take place in Valencia, Spain, as many organizations working on conservation in different parts of the world will attend, such as African Parks or the Australian Wildlife Conservancy. The goal of these sessions is none other than to share experiences.

Q

What role does outreach play in conservation?

A

Outreach is fundamental. We make a big effort to communicate about our projects and use social networks and the press a lot to do so. Our communication is based on transferring messages of hope, talking about specific solutions to environmental problems. To do so, we receive lots of people who come to see the projects. Politicians, scientists, donors and journalists, who come to see firsthand the results achieved. We believe that it is the best way to involve everyone.

We also use a lot of "personal" stories about the animals to transmit key messages, as people really empathize with these kinds of stories.

In the last twenty years, there has been a nine-fold increase in the the number of lynxes that live between Spain and Portugal thanks to the species reintroduction program.

CO_2 Capture Technologies, a Key Tool to Decarbonize the Economy

INTERVIEW WITH:

Mercedes Maroto-Valer

Director of the UK Industrial Decarbonisation Research and Innovation Centre (IDRIC).

Q

What are the most urgent measures we need to take to curb climate change?

A

There is no single option that will solve everything. We have to develop a range of solutions and whatever option we consider, the need for urgency must always be kept in mind. When we talk about climate change, we generally think of 2050, which is the deadline for achieving carbon neutrality. However, the really key year is 2030, by which time we must have achieved a 50% reduction in global carbon dioxide emissions. That is the urgency.

We are emitting billions of tons of CO_2 globally. To reduce these emissions, there are different solutions depending on the type of sector that emits CO_2, the amount of CO_2 emitted or even the geographical location of the emitting company. We have to look for solutions that are quick, due to the urgency of 2030, but at the same time are scalable and will allow us to achieve a just transition.

Q

Decarbonization of the economy is key. Which sectors are easiest to decarbonize and how decarbonized are they today?

A

To meet emission reduction targets and achieve net zero, everything must be decarbonized. In recent years we have managed to reduce many of these CO_2 emissions because one sector in particular, the electricity generation sector, has been decarbonized. Thanks to renewable energies we have managed to reduce our CO_2 emissions from electricity production significantly. And although nothing is easy in the fight against climate change, this is one of the easiest tasks.

Closure of flame in rotary kiln during heating mode in cement plant.

"To meet emission reduction targets and achieve net zero, everything must be decarbonized".

What we are left with now is increasingly difficult, to the point that there may be some sectors that we will not be able to decarbonize. That is why we have started to capture CO_2 directly from the atmosphere.

Industry is one of the most difficult sectors to decarbonize, as is the transportation sector, especially the aviation sector. This is also true for the thermal process sector such as heating. There are several reasons why these sectors are difficult to decarbonize. For example, the materials used in their processes emit CO_2 precisely during the process. Thus, even if we use renewables for all the energy supply that a cement plant needs, for example, the cement plant will continue to produce CO_2, because it is produced in the transformation of the materials used in these factories (by subjecting some raw materials such as limestone to high temperatures). Concerning the aviation sector, it is very difficult to decarbonize long-haul flights because there are no batteries or electric options to replace the fuels currently used.

What we are doing is analyzing which of these sectors can be innovated in order to decarbonize them.

Q

What role do CO_2 capture technologies play in this process? What do they consist of?

"The choice of the most appropriate technology will depend on how the CO_2 is produced, the temperature, pressure or carbon dioxide concentration conditions".

A

There are several types of technologies within the framework of CO_2 capture, storage and use. These are called CCS technologies.

When CO_2 is produced in a thermal power plant or in a steel or cement plant during the production of steel, cement or fuels, it is not emitted alone, but rather in conjunction with a number of other gases. Most of these other gases (e.g. nitrogen) are quite harmless.

The first thing to do is to capture that CO_2 and separate it from the gases with which it is mixed, which can be emitted into the atmosphere because they are not as risky. Once it is captured, it has to be transported to the place where it will be stored or used. It is therefore a process involving different technologies.

Even within the capture process itself there are several options. It can be captured using filters or membranes, using a solvent that dissolves the CO_2 but not the other gases, or even using filters similar to those you may have at home to purify water, which retain the CO_2 but let the rest of the gases pass through.

The choice of the most appropriate technology will depend on how the CO_2 is produced, the temperature, pressure or carbon dioxide concentration conditions.

Q

There are also technologies to capture CO_2 directly from the atmosphere. **Are these the same technologies?**

A

To some extent, yes. Some of the materials used to capture CO_2 from a specific emission point are similar to those used to capture CO_2 from the air. The difference is that here the CO_2 concentration is much lower (today around 412 ppm compared to values that can reach 30% when it is captured directly in industry, for example).

Which of the two options is better? It depends. There are cases of specific points where we have a lot of CO_2 being emitted in an industrial sector and we have to try to recover it from there. There are other cases in which, no matter how much we do, we will not be able to capture it. This is the case, for example, in the automobile sector. It is very difficult to create a system for capturing, transporting and storing CO_2 from a car. In that case, the most appropriate option will be to capture that CO_2 once it has reached the atmosphere. This is more technologically challenging, as the more dilute concentrations are captured, but the basic principle from a chemical engineering point of view is very similar.

"It is very difficult to create a system for capturing, transporting and storing CO_2 from a car. In that case, the most appropriate option will be to capture that CO_2 once it has reached the atmosphere".

Q

At present, how much CO_2 is being captured and how much would need to be captured to achieve climate neutrality? Are we on the right track?

" CO_2 capture and storage could contribute to slowing climate change by removing some 6 billion tons of carbon from the atmosphere".

A

Not enough is being captured. Today we are capturing around 40 million tons of CO_2. That may sound like a lot, but we have to put this figure in perspective. Globally, we emit about 35 billion tons.

However, these are technologies that we know can be implemented. Since 1996, for example, a carbon capture and storage project has been underway in Norway that is capturing close to one million tons each year.

CO_2 capture and storage could contribute to slowing climate change by removing some 6 billion tons of carbon from the atmosphere. But we need to go a step further and develop and deploy these technologies at a much faster pace than we have done so far.

Q

And how is that done?

"Capturing and storing CO_2 also allows us to produce hydrogen that is low in carbon".

A

These technologies have been applied mainly for CO_2 abatement in thermal power plants or in oil and natural gas production. Now what we are doing is rolling out these technologies in the industrial sectors we talked about above, such as cement or steel, sectors that are difficult to decarbonize and where these technologies have not yet been applied.

There is a level of innovation where we can still contribute to lowering costs and risks and accelerating roll-out of these technologies. It is being done, but still at a slow pace, and that is where innovation plays an important role. For half of the global emissions cuts, we do not yet have a technology that can be implemented.

Capturing and storing CO_2 also allows us to produce hydrogen that is low in carbon as well as produce fuels for the aviation sector, another area that is very difficult to decarbonize. So it allows us to play with various types of CO_2 emitters. The problem is that we have not yet managed to deploy the technology in most of these carbon emitters. We need to achieve a much larger and much faster deployment than we have achieved so far.

Q

What is the general attitude of the different industrial sectors towards decarbonization?

"Today, there are very few companies, especially if they operate in international markets, that do not have a sustainability plan".

A

This has changed a lot. There is greater awareness in the industrial sector of the need to carry out an energy transition. Companies are clear that they cannot continue doing things the same way as before, although they may not have decided what path they need to follow to do so, what technologies can help them or how to finance this transition. This is exactly where innovation can help.

Today, there are very few companies, especially if they operate in international markets, that do not have a sustainability plan. It doesn't mean that they have determined exactly how to be more sustainable, but that is where we have to help them.

Companies have also realized that if they can produce with lower emissions, they will generate a new industry. In the UK, for example, it has been estimated that if we manage to use carbon capture, storage and utilization technologies for everything that can be used, up to 50,000 jobs could be generated by 2030. We must therefore work to find the best solution for each industry.

Q

What is done with the CO_2 that is captured? How do we "get rid" of it and make sure it does not go back into the atmosphere?

A

The first thing to do is carefully study the sites that can really serve as CO_2 storage sites. Generally, these are deep geological deposits where there is saline water, which means that this water is not suitable for human consumption. A depth study is then carried out, because the greater the depth, the more the CO_2 is compacted, which makes storing more CO_2 in a smaller area possible. In addition to the depth, the geological formation must have a kind of cap that prevents the CO_2 from moving upwards.

Many of these geological formations have previously contained natural gas. What they have done is to extract the natural gas and introduce the CO_2. Sometimes, as the CO_2 is introduced, a little more natural gas is recovered. This is called Enhanced Gas Removal (EGR). And, apart from carefully analyzing where the CO_2 is going to be stored, monitoring and verification processes are carried out to check that the carbon is there.

Another option we have is to use the CO_2 that has been captured to produce chemicals or fuels. The problem here is that, in the case of chemicals for example, these are very small markets, without the capacity to use all the CO_2 captured. This would be different if we were able to convert that CO_2 into fuel, because then we would have much larger markets. However, this technology is not yet sufficiently developed and deployed to say that it is the way to combat climate change.

Q

For all the measures that countries are adopting to have a real effect on climate change, a global commitment and collaboration is essential. **Does this collaboration really exist or is each country "playing its own game"?**

"What is really important is to see how we can help all these companies, cities and governments to establish a roadmap".

A

During the UN Climate Change Conferences (or COPs) such an expectation is generated in the media that it seems that all problems will be solved there and that if they are not solved at that moment they will not be solved ever or until the next COP. And, although these summits are very important due to the fact that decisions are taken at a global level, the reality is that intense work is done before, during and after them. The thing is that this work isn't as visible.

Today, many countries, companies and cities have made commitments to reach zero emissions. What we still lack in many of these commitments is not so much ambition or a target, but action. And this is a daily challenge. If we are to reach the goal of reducing emissions by 50% by 2030, 2020 has to be the decade of action.

What is really important is to see how we can help all these companies, cities and governments to establish a sufficiently detailed roadmap to meet these objectives. And we are making progress on that, albeit slowly.

We also need to be very realistic: we are going to exceed the 1.5 degree increase in the planet's temperature, a goal set in the Paris Agreement. With what was achieved at COP26 in Glasgow, we will drop from the current 2.7 degrees to 2.4 degrees, a drop that was acknowledged to be insufficient. As a consequence, the nationally determined contributions, i.e., the emission reduction commitments of each country, will have to be reviewed by the countries before COP27 (previously they were reviewed every five years). The important message being conveyed is that although we are on the right track, we are not going to get there, and therefore we must all review what we can do and increase our commitments.

Sharm el-Sheikh (Egypt) COP27 site.

Q

You are Director of the Industrial Decarbonization Research and Innovation Centre in the U.K. **What does your work involve?**

A

Out of all the sectors that we need to decarbonize, the industrial sector is a very important and difficult sector to decarbonize. In the UK, emissions from the industrial sector represent about 20% worldwide but at the same time it is a sector that generates 9% of the country's GDP. So it is a sector that has its problems because it produces CO_2 and yet at the same time it is a very necessary sector. Not just to produce steel or cement but also for renewable energies because, for example, windmills need steel and cement.

In 2021, the United Kingdom was the first country in the world to publish a strategy focused on industrial decarbonization. Within that strategy, budgets were allocated to carry out infrastructure projects and create roadmaps for different sectors. Additionally, there is a research and development center to support the infrastructure plans and roadmaps.

At the end of 2019, I was selected to lead that research center. In 2020 we defined the center's objectives and started to develop the plans. And since 2021 we are already developing and executing actions. We manage a total of 142 partners, more than half of which are companies in the industrial sector and we aim for the UK to be the first country in the world to have a cluster, an industrial region, with net zero emissions, by 2040. During the 2020s we will launch two low-carbon industrial zones. In 2030 we will add two more and by 2040 we will have one that will be net zero.

"During the 2020s we will launch two low-carbon industrial zones. In 2030 we will add two more and by 2040 we will have one that will be net zero".

Not only do we work with the technology sector, but we also understand that these technologies

"Not only do we work with the technology sector, but we also understand that these technologies need a regulatory framework and financial models".

need a regulatory framework and financial models. And putting all these elements together is when you really get an industry that thrives.

The aim is to attract investment to the UK because these are going to be leading sectors where technology has been developed and proven. The aim is to maintain the industry, create new jobs, attract investment and export technology.

The government has invested £210 million, the private sector £250 million and £1 billion has been added to this for CO_2 capture and storage projects, of which two have already been identified and have already started to be developed in recent months. This represents a unique opportunity to boost and accelerate these technologies.

This is not an expense or a cost but an investment. I like to say that "he who invests, prospers". And the way to prosper is by investing in innovation and investing in the energy transition.

Q

What lessons from the UK could be transferred to other countries?

A

What is essential for any country is that the government, companies and universities work together and in a coordinated manner. Companies, the government and the financial sector come to the Industrial Decarbonization Research and Innovation Center with a specific need, and what we do is identify, among the 23 universities that work with us, the best researchers and the best ideas. And we all work together on a daily basis. By working side by side, what we achieve is that these solutions are put into practice much sooner.

The key is for research, innovation, business and the financial framework to come together from day zero of a project's inception, co-creating ideas and developing and implementing solutions together.

Solar Geoengineering to Cool Down Our Planet

INTERVIEW WITH:

David Keith

Professor of Applied Physics at the Harvard School of Engineering and Applied Sciences and Professor of Public Policy at the Harvard Kennedy School, and founder of Carbon Engineering,

Q

What is solar geoengineering? What role could it play in the fight against climate change?

"The next approach is stratospheric aerosol injection, an approach which has got by far the most research attention and understanding. The core idea is putting aerosols in the stratosphere. There are many types of aerosols which could in principle be put there".

A

Solar geoengineering is a set of ideas for deliberately altering the Earth's radiative balance by reflecting a little bit more sunlight back into space, with the goal of reducing some of the long run risks from accumulated CO_2.

There's a big range of solar geoengineering approaches. Moving down from far out in space to the surface, the first one would be making structures, like shields, in space between the Earth and the Sun, to block out sunlight. It may seem a little ridiculous, but this is a 100-year old problem and I don't think it's ridiculous to think about it. Although it's clearly not something we'll do in the next decades.

The next approach is stratospheric aerosol injection, an approach which has got by far the most research attention and understanding. The core idea is putting aerosols in the stratosphere. There are many types of aerosols which could in principle be put there (the one we understand the best is sulfuric acid), and there are several ways to do it. I think it's the only approach which could be done relatively soon, starting maybe in a decade, and it could reduce temperatures and many other climate risks in a pretty uniform way.

Then there's ideas for making thin cirrus clouds (which tend to warm the planet) a little less prominent as well as some seeding ideas for cirrus clouds that haven't been explored much.

The two last categories would be marine cloud brightening and making the surface brighter by adding to the surface reflectivity (by painting roofs white, for example).

Q

You are co-founder of Harvard's Solar Geoengineering Research Program. **What is the aim of this program?**

A

The aim is to have a broader understanding of these technologies, understand their performance, their environmental risks and how they might be governed.

It's a very broad program. We fund a big range of researchers, people with a real diversity of views. Some people actually oppose even researching these technologies, so we wanted to have a large range of people involved.

The idea behind the program is to be useful to the world by improving our knowledge of these technologies and the knowledge that policymakers should have in order to make decisions.

Q

Last year the program planned to launch a field test called the Stratospheric Controlled Perturbation Experiment. **What was the experiment and why was it finally canceled?**

A

That was a small experiment, led by Harvard Professor Frank Keutsch and myself, designed to try and improve our understanding of the way aerosols behave in the stratosphere and the way aerosol plumes form in the stratosphere. We were attempting to do a flight of just a balloon gondola in Sweden, it wasn't even the experiment, but it was stopped ultimately by the Swedish government.

Q

Isn't "playing" with our planet's temperature dangerous? What are the possible risks?

A

Nobody should be playing with our planet's temperature. Obviously, altering the climate is dangerous. That's why we're worried about climate change. And we're trying to deal with the dangers of the accumulated carbon dioxide in the atmosphere. We're certainly going to put some more carbon dioxide in the atmosphere because we can't just stop emitting tomorrow.

The issue is how to manage those risks. And yes, it's certainly true that solar geoengineering, which is one of the ways to limit those risks, has its own set of risks, a big long list of them. So the answer is yes, it is dangerous. But if you are looking for a risk-free solution to a complicated problem like climate change, you're naive.

Q

If we were to finally go ahead with solar geoengineering: **who should be in charge of monitoring the effects? How would we make sure that it was responsibly governed?**

"What individuals can do is to attempt to do their best, to try to advocate ways that this could be done with some justice, in ways that are consultative and practical".

A

We can't make sure it is responsibly governed. After all, we can't make sure the internet is responsibly governed. There are many sorts of things we can't govern responsibly. We haven't governed the distribution of vaccines very responsibly and we haven't responsibly governed emissions cuts. There is no global sovereignty.

What individuals can do is to attempt to do their best, to try to advocate ways that this could be done with some justice, in ways that are consultative and practical. That's what I try to do. There is no magic answer where you can guarantee that it will be done correctly. Trying to be transparent and honest about how effective it might be and what the risks are, and trying to talk practically about how decisions can actually be made; those are the most important things that anyone can do.

It is also important to consider two sides of the risk coin. It is true that there are risks in solar geoengineering and there are ways humans might do it and regret it, and that it would end up being worse than if we hadn't. But there's also the opposite. There are risks that if we don't do it, we miss the opportunity of saving a lot of lives and reducing climate risks in the next half century. Both risks are real.

Q

Solar geoengineering is highly controversial. In January this year a group of 60 scientists signed an open letter calling on political institutions to place limits on solar geoengineering research so that it cannot be deployed unilaterally by countries, companies or individuals. **What is your opinion?**

A

Solar geoengineering is an idea, you can't really be in favor of or against it. You can be against or in favor of certain kinds of research or its deployment under certain circumstances. But you can't be for or against the idea itself.

I'm not for nor against solar geoengineering. I'm in favor of learning more and there are people who are against that and they have their reasons. I'm against some kinds of deployment.

The controversial part of this letter was that the group was very close to asking for a permanent de facto ban on research. They argued there should be no assessment by the IPCC, no government funding for research and no research that is empirical. They're not in favor of research, period.

In my opinion, to begin with, it's an odd ethical position because, after all, the people who signed this letter are mostly rich-world people, in cooler countries, which are mostly isolated from climate risks. And they're suggesting we do less research on something that, at least given current evidence, is most useful for reducing climate risk, particularly for the most vulnerable, for poor people who live in hotter countries.
It's quite a thing to say that we should just know less, that we shouldn't learn more about things, including learning more about its risks. You have to be extraordinarily confident that a thing makes no sense to say that. And they didn't offer any basis for that. The argument that they gave was that it couldn't be governed justly, where they defined justly as some kind of collaborative thing where everybody gets to be consulted. And they're right, it can't be governed that way,

"I'm not for nor against solar geoengineering. I'm in favor of learning more and there are people who are against that and they have their reasons".

because that's not the way the world is now. But if you were to say that we shouldn't deploy technologies without that kind of governance, you also should not deploy the COVID vaccines, because the COVID vaccines have a possible misuse. The underlying technology can be used for weapons, and they weren't used justly. They didn't meet those governance criteria. So if you really believe that nothing that doesn't meet that criteria should be deployed or researched, then you basically shut down all research on anything. It's a very high claim.

Q

Will our generation witness the deployment of solar geoengineering?

A

I don't know. I don't think people are good at guessing these things. Even if the technology already exists. Many technologies that are possible have never been implemented. It's very difficult to guess what technologies will end up being implemented. I, at least, cannot.

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